Apparatus for coagulating tissue

DESCRIPTION

The invention relates to an apparatus for coagulating tissue, comprising an electrode that is connected to an HF generator for generating a high-frequency current, and a tube, a pipe-like probe or similar gas-delivering device that propels argon or a similar inert gas from an outlet of the gas-delivering device into a space between the electrode and the tissue, with a prespecified direction of flow.

Such an apparatus is known, for instance, from the document DE 41 390 29 A1. In this apparatus the gas flows axially from the outflow opening of the gas-delivering device to the electrode, and the electrode is positioned in front of the opening, so that the plasma tends to be produced in a direction axial to the gas-delivering device. Especially when an endoscopic operation is being performed within a body cavity, i.e. under confined conditions, it is difficult to coagulate tissue sites situated at the side, in a direction radial with respect to the opening.

The document DE 198 202 40 C2 discloses a tissue-coagulating apparatus in which the electrode is disposed entirely within a tubular probe provided with a slit-shaped opening that passes helically around its circumference, so that the delivered gas and also the plasma emerge in a direction radial to the probe. One problem here resides in manufacturing such probes, in view of the confined spatial relationships. Another is that the probe material can relatively easily be damaged by the high temperatures of the plasma.

It is the objective of the invention to develop an apparatus of the kind cited at the outset further in such a way that by simple means it becomes possible reliably to specify a direction of the plasma beam that deviates from an axial direction.

This objective is achieved by an apparatus of the kind cited at the outset in that the distal end of the electrode projects out of the gas-delivering device, and at said distal end a guiding device for directing and guiding the gas and/or the plasma is disposed in such a way that at least part of the flowing gas/plasma is diverted into the prespecified direction.

An essential point of the invention resides in the fact that the electrode itself is structurally included in the overall mechanical construction of the device, in that it to some extent carries part of the gas-delivering device, namely the guiding device. The preferred direction of the gas or plasma is thus determined by the guiding device. It should be pointed out here that within a space completely filled with an inert gas, the direction in which the plasma is generated is not influenced by flow of the gas. However, because the plasma always appears along the path of least overall resistance, and it is practically impossible for the the space to be filled entirely homogeneously, even in a body cavity, on one hand it is possible by way of the guiding device to specify the gas current and hence the gas concentration within the space, and on the other hand the desired change of direction can be brought about by an extension of the path the plasma must follow from the electrode to the tissue.

Preferably the guiding device consists of an electrically insulating material, as a result of which the above-mentioned change of path is facilitated.

Furthermore, the guiding devices preferably are made of a thermally stable material, so that during an operation, even if

the guiding device is in prolonged contact with the plasma, there are no damaging alterations of the material. A particularly suitable material is a ceramic, which can be applied for instance by spraying on or by dipping.

The electrode is preferably constructed in the form of a rod or wire, as is known per se, while the guiding device is preferably disposed in an axially symmetric manner around the electrode, in such a way that the gas/plasma flows into the surrounding space substantially radially with respect to the outlet of the gas-delivering device. This arrangement makes it unnecessary for the apparatus to be rotated within a body cavity during an endoscopic operation in order to coagulate regions of tissue situated radial to the outlet. All that is needed is to bring the apparatus into the vicinity of the tissue site to be coagulated, because the plasma (as explained above) seeks out the shortest and hence lowest-resistance path. The plasma current does not change direction until the plasma path is lengthened, when the treated tissue dries out and hence in turn acquires a higher resistance.

The guiding device is preferably made concave on its side that faces the outlet, as a result of which a diversion of the gas stream that favors its flow is accomplished in an especially simple manner.

To prevent mechanical injury caused by touching the tissue, the guiding device is rounded on its side that faces away from the outlet. The guiding device thus simultaneously constitutes a form of protection against direct contact between electrode and tissue, which could have fatal consequences, as is well known.

The electrode in one preferred embodiment of the invention is made movable relative to the outlet, in such a way that when it is in a retracted state, the guiding device closes the outlet in a substantially leakproof manner. This can ensure that

during introduction of the probe no body fluid or other contaminants can enter the gas-delivering device.

In the following, preferred embodiments of the invention are described in greater detail with reference to drawings, wherein

Fig. 1 shows a perspective view of a first preferred embodiment of the invention, with peripheral devices indicated schematically,

Fig. 2 shows a second preferred embodiment of the invention, in a drawing similar to that in Fig. 1, and

Fig. 3 shows a third embodiment of the invention, in a drawing corresponding to that in Fig. 2.

In the following description, the same reference numerals are used for identical parts or parts with identical actions.

Figure 1 shows an end piece of a probe, comprising a gas-delivering device 10 in the shape of a tube, the lumen of which communicates with a gas source 12 by way of a conduit 11. An electrode 3 (ordinarily made of tungsten) is disposed substantially coaxially within the gas-delivering device 10, and is connected to an HF generator by way of an electrical conductor 2. A distal end 4 of the electrode 3 projects outward through an outlet 13 of the gas-delivering device.

Attached to the distal end 4 of the electrode 3 in the embodiment of the invention shown in Fig. 1 is a spherical ceramic part that forms a guiding device 20. A stream of inert gas, supplied by the gas source 12 and emerging from the outlet 13, is diverted by this arrangement into the direction indicated by the arrow P. If the arrangement is positioned near and parallel to a tissue surface 5, the space delimited by the guiding device 20 in combination with the end-region of the gas-delivering device 10, at its outlet 13, is restricted

sufficiently that when the supplied inert gas is ionized by a high-frequency current coming from the generator 1, the shortest path available to the resulting plasma between the electrode 3 and the tissue surface 5 is oriented radially with respect to the electrode 3. As a result, the guiding device 20 serves not only to determine the direction of flow of the supplied inert gas, but also to "guide" the plasma.

The embodiment of the invention shown in Fig. 2 differs from the embodiment in Fig. 1 in that the guiding device 20 is not spherical but rather is shaped like a valve for an internal combustion engine, comprising a concave inner section 21 in the region opposite the outlet 13 of the gas-delivering device 10. The distal end of the guiding device, facing away from the gas-delivering device 10, is flattened. The transitional region between the flattened distal section and the inner section 21 has a rounded contour 22 such that no mechanical damage to the tissue can be caused by contact with the tissue surface 5.

The embodiment of the invention shown in Fig. 3 differs from the embodiment in Fig. 2 in that instead of being flat, the distal section of the guiding device 20 is hemispherical, and thus as a whole constitutes a rounded contour 22 that likewise reduces the risk of injury.

The electrode 3 can be made retractable and/or can be pushed forward, out of the outlet 13, so that when the electrode 3 is in the retracted state the guiding device 20 is seated on the outlet 13. This positioning avoids the danger that during insertion of the gas-delivering device 10 or a correspondingly designed probe, body fluid or the like will enter the lumen of the gas-delivering device 10, because when in this state the outlet 13 is closed.

List of reference numerals

1	HF generator
2	Electrical conductor
3	Electrode
4	Distal end
5	Tissue surface
10	Gas-delivering device
11	Conduit
12	Gas source
13	Outlet
20	Guiding device
21	Inner section
22	Rounded contour